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Original Article

Impact of pulmonary rehabilitation program with cycle ergometry in chronic obstructive pulmonary disease

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Abstract

Aim: To evaluate impact of pulmonary rehabilitation (PR) on quality of life (QoL) and respiratory variables in Chronic Obstructive Pulmonary Disease (COPD).

Materials and methods: PR program for 3 times per week for 8 weeks were performed in patients with COPD. Breathing, upper extremity strengthening and cycle ergometry exercises were performed. PFTs, MMRC dyspnoea scale, BODE Index and 6-minute walking test (6-MWT) were evaluated baseline and after treatment in all patients with COPD. Beck Depression Inventory and State-Trait Anxiety Inventory (STAI I and II) were used for evaluating depression and anxiety and QoL was evaluated with SF-36 scale. Patients having any other cardiac or pulmonary co-morbiditites, inability for attending rehabilitation program (due to physical, physicologic or neurologic problems) were excluded.

Results: A total of 50 patients were included (45 male and 5 female patients). Mean age was 59.4±8.8 (56-62). Improvement was detected in exercise capacity, dyspnea severity, QoL, anxiety, and depression levels. Improvement in PFT results were obtained after exercise program.

Conclusion: PR program with cycle ergometry is effective in patients with COPD.

Keywords: Rehabilitation; exercise; chronic lung disease; anxiety

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD), the most common pulmonary disease, causes serious disability and mortality. COPD is an irreversible lung disease with flow limitation. Decrease in exercise capacity and increased dyspnea occurs as disease progresses. Exercise intolerance has negative impact on daily activities as well as quality of life (QoL). Exercise limitation is present as result of functional loss in COPD patients (1). Ventilatuary, cardiovascular, peripheric and respiratory muscle function impairment, increased dyspnea and physical factors plays role on exercise limitation (2). Although significant advances have been made in the treatment of COPD, most of these interventions are not curative and the need for supportive rehabilitation programs becomes important (3).

Patients with COPD often have comorbidities. These comorbidities are: cardiovascular diseases, metabolic syndrome, diabetes mellitus, depression and anxiety (4). Anxiety and depression are often accompanied and aggravate the clinical condition of patients (5). Depression and anxiety were associated with the number of hospitalizations, mortality and exacerbation in patients with COPD (6).

Pulmonary rehabilitation (PR) is a multidisciplinary program which is used to achieve increased physical capacity and establish unrestricted daytime activities and decrease symptoms&hospitalizations in chronic respiratory disesases (7). PR is known as effective in COPD treatment however there are few studies about impact of exercise program on daily activities and QoL (8). PR has positive effects on mortality and disease progression and reduces the use of healthcare resources (9,10). PR improves health status, reduces dyspnea and increases exercise capacity (11-13).

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Although the effect of depression and anxiety is known in COPD, there are few studies on the effectiveness of PR on anxiety and depression (14, 15). Therefore, we aimed to evaluate effectiveness of cycle ergometer exercise program with respect to exercise capacity, pulmonary functions, QoL, anxiety and depression in patients with COPD.

MATERIALS and METHODS

This study was designed as a pre-test post-test. Patients aged 18 years or older diagnosed with COPD in the pulmonary medicine clinic were prospectively included in the study.

The study was conducted between April 2012 and April 2013. COPD was diagnosed with Global Initiative for Chronic Obstructive Lung Disease (GOLD) classification (16). Seventy-two patients were initially included in the study. 22 patients did not meet inclusion criteria. 50 patients were included in the study and included in the 8-week PR program (Figure 1).

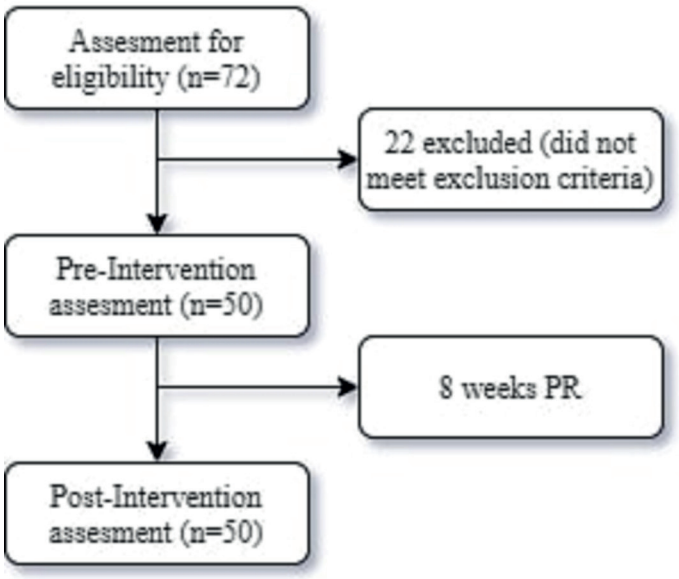

Figure 1. Flowchart of study

Pulmonary function tests (PFT) were evaluated by spirometry (Vmax Spectra 229) aerobic capacity measurements were obtained pre and post rehabilitation program. The tests were made according to the guideline of the American Thoracic Society and the spirometry device was calibrated daily. Forced expiratory volume in 1 second (FEV1), forced vital capacity (FVC) and FEV1/FVC values were recorded.

The inclusion criteria were: To be diagnosed according to the GOLD guidelines, to be 18 years of age and older, stable clinical status and not participating in any pulmonary rehabilitation program, to understand the instructions provided. Presence of any other cardiac or pulmonary co-morbiditites, inability for attending rehabilitation program due to physical, physicologic or neurologic problems were exclusion criteria.

Demographic variables were recorded. Body mass index (BMI) was calculated for each subject. Physical examination was performed by the same doctor in prior and after the rehabilitation program. This doctor has 8 years of experience with pulmonary rehabilitation. PR was consisted of 8 weeks outpatient program and included patient education, exercise program, emotional evaluation and dietary recommendations (low calory intake with more number of meals, adequated fluid intake, and protein rich intake and carbohydrate restriction).

Severity of airflow limitation post bronchodilator was rated according to the GOLD classification. Staging was done according to GOLD stages are defined as follows: stage I (mild), FEV1/FVC <0.7, FEV1≥ 80% of predicted; stage II (moderate), FEV1/FVC <0.7, FEV1 <80% of predicted; stage III (severe), FEV1/FVC <0.7, FEV1 <50% of predicted; and stage IV (very severe), FEV1/FVC <0.7, FEV1 <30% of predicted (17).

PFT, physical capacity, 6 minutes walking test (6-MWT) were performed for each subject (18). QoL was evaluated by Short Form-36 (SF-36) Questionnaire (19). SF-36 has ability to assess 8 concepts: Physical function (10 topic), physical activity limitation, (4 topic), body pain (2 topic), health (5 topic), vitality (4 topic), social function (2 topic), emotional role limitation (3 topic), mental health (5 topic). Every topic is scored from 0-100 with 100 refers good health.

6-MWT was performed for evaluating exercise capacity. Prior to test all patients were rested 10 minutes and completed 6 minutes walk in a 20 meter hall in the clinic. Dyspnea severity was evaluated by mMRC scale and disease severity was evaluated with BODE index.

Anxiety level was evaluated with STAI: State-Trait Anxiety Inventory (STAI form TX-I and TX-II). STAI consists of 2 subscales. State anxiety scale showed the level of anxiety in a given situation, the situation in trait anxiety scale evaluates anxiety level independent of the individual situation. The scores on both scales are distributed between 20 and 80. Higher values refer higher level of anxiety. Depression level was evaluated with Beck Depression Inventory (BDI), disease severity and dyspnea level was evaluated by BODE index and modified Medical Research Council dyspnea scale (mMRC) (20, 21). All parameters were evaluated before and after treatment (at week 8).

Respiratory, upper extremity and cycle ergometry exercises were performed in each program 3 times per week for 60 minutes. Respiratory exercises were consisted of pursed lips breathing, bending forward posture, diafragmatic respiration (abdominal), and relaxation training techniques was described and applied. The patient breathes through the mouth, then breaths for a few seconds, then slowly exhale for 4-6 seconds in the whisper position in pursed lip breathing. Patients sits 20 to 45 degrees forward to the vertical axis and makes pursed lip breathing in bending

forward posture. The patient in the supine position puts his/her hand to upper-middle portion of the abdomen with dominant hand, and non-dominant hand to upper- fore chest in diafragmatic respiration technique. Patient takes air from the nose, and gradually expires with pursed lip breathing. During this procedure, the hand on the chest is not moving as much as possible but tries to move diaphragm to the flaccid abdomen as much as possible. Patients feel the abdomen rise although rib cage dose not move during inspiration.

Exercise program was composed of respiratory muscle exercises, upper extremity-shoulder girdle exercises and endurance (aerobic resistance) exercises. For the exercise training of upper extremity-shoulder girdle muscles (subclavius, pectoralis major and minor, serratus anterior, trapezius, upper and lower part of the latissimus dorsi, sternocleidomastoid muscle) arm wheel exercises and then gravity resistance exercises with 1-2 kg weights, under the supervision of physicians and physical therapists was performed 3 times a week for 20 minutes. Exercise intensity was gradually increased. Resistant exercises were reviewed after every 3 sessions. Exercise intensity was adjusted according to the patient's tolerance.

Cycle ergometer; was performed with cycle Ergometer Device (Ergoline, ergoselect Reha 200) and a 5-minute warm-up phase, training phase for 20-30 minutes, 5 minutes to cool down phase to be resistant aerobic exercise training, applied 3 times a week. Before starting treatment, all patients were performed cardiopulmonary exercise test with cycle ergometry and the maximum heart rate was calculated. Aerobic exercise training was initiated 70-85% of maximal heart rate as submaximally increases of resistance were provided when with patient tolerance was increased (mean 35-50 watt). Vital signs such as blood pressure, heart rate, oxygen saturation (SpO2) were monitorised during the procedure. Oxygen support was provided when oxygen SpO2 was less than 90%.

Ethics committee approval and informed consent were obtained. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Statistical Analysis

Statistical Package for Social Sciences (SPSS) for Windows 15.0 program was used for statistical analysis. The normality of data distribution was evaluated using the Shapiro–Wilk test. Paired Sample T test were used for mean values and comparisons. Data was shown as mean±standard deviation. p<0.05 was accepted for statistically significance.

RESULTS

Study population was consisted of 45 male and 5 female patients. A total of 50 patients were included. Demographic variables were shown in Table 1. Mean age was 59.4±8.8 (56-62) and mean year of diagnosis was 8.9±9.3 years. BMI was 30.3±4.1. Ten patients were current smoker and 33 were ex-smoker. Sixty-one percent of patients (n=21) were receiving long term oxygen treatment. Improvement in PFT results were obtained after exercise program. PFT results were presented in Table 1. Patients distribution were as follows: Stage 1: 5.6% (n=3), Stage II: 29.6% (16), Stage III: 24.1% (n=13) Stage IV: 27.8% (n=15). Improvement in all stages of COPD were detected after PR with respect to FEV1 values (p<0.000) (Table 1).

There was significantly improvement in both BODE index and mMRC (p<0.001). There was a significant increase in 6-MWT results (p<0.001) (Table 1).

Table 1. Pulmonary functions in pre and post pulmonary rehabilitation program

Variables	Pre-pulmonary rehabilitation (Mean±SD)	Post-pulmonary rehabilitation (Mean±SD)	p
FEV1 (%)	48.4±12.7	54.2±13.2	0.200
FVC (%)	72.7±22.2	79.4±13.2	<0.001
FEV1/FVC (%)	51.4±4.5	57.3±4.4	<0.001
MRC	1.7±0.1	1.1±0.1	<0.001
Bode index	2.7±1.8	1.9±0.7	<0.001
6MWT (m)	485.2±77.4	564.9±72.9	<0.001

Significant improvements were observed in all 8 parameters of SF 36 after PR (p<0.001) (Table 2). Mean BDI score was detected as 16.4±0.5 ve 9.4±0.6. STAI I and II were found as 38.5±9.8 and 28.3±5.7; 42.7±7.5 and 35.8±8.5; respectively. BDI, STAI I and II were improved after treatment (p<0.001) (Table 3).

Table 2. Quality of life results in pre and post pulmonary rehabilitation program

	Pre-pulmonary rehabilitation (Mean±SD)	Post-pulmonary rehabilitation (Mean±SD)	p
Physical function	63.5±12.3	76.4±9.2	<0.001
Physical activity limitation	33.2±16.6	63.6±12.4	<0.001
Body pain	51.3±2.9	77.5±9.7	<0.001
General health	46.5±9.0	66.3±7.7	<0.001
Viability	31.5±9.4	51.4±8.6	<0.001
Social function	44.5±9.4	69.6±9.3	<0.001
Emotional role limitation	52.3±8.5	79.8±13.5	<0.001
Mental health	52.1±7.6	64.1±10.7	<0.001
Social function	44.5±9.4	69.6±9.3	<0.001
Emotional role limitation	52.3±8.5	79.8±13.5	<0.001
Mental health	52.1±7.6	64.1±10.7	<0.001

SF-36: Short Form-36

Table 3. Anxiety and depression levels in pre and post pulmonary rehabilitation program

Variables	Pre-pulmonary rehabilitation (Mean±SD)	Post-pulmonary rehabilitation (Mean±SD)	p
STAI State Anxiety Scale	42.5±9.8	29.3±6.7	<0.001
STAI Trait Anxiety Scale	49.7±7.5	36.8±8.5	<0.001
Beck Depression Inventory	16.4±0.5	9.4±0.6	<0.001
MRC	1.7±0.1	1.1±0.1	<0.001

STAI: State-Trait Anxiety Inventory

DISCUSSION

We showed that 8 week PR program has improved pulmonary functions, exercise capacity, QoL, depression, anxiety and dyspnea levels in this study. Complaints in COPD are result of respiratory gas exchange and increased ventilatory demand due to peripheric muscle weakness. Respiratory limitation is most difficult symptom in COPD and it causes reduction in physical activity with time. Breathing difficulties and physical limitations affect the patient's emotional state as well as the emergence of secondary diseases of inactivity due to a number of causes. We detected decreased work load and dyspnea after PR in our patients. In other study patients attended chronic Disease Self-Management with/without exercise programs. Exercise program was consisted of aerobic and strengthening exercises for upper and lower limbs one hour of weekly exercise for 6 weeks. A total of 69 patient were completed the program. Fifty two percent of patients had stage I or stage II COPD. They detected improvement in 6-MWT however there was no significant difference between groups. They did not find any difference among groups with respect to SF-36 parameters and concluded that exercise had no additional effect on self management (22). In our study 35% of patients had stage I and II COPD. Longer PR program with cycle ergometer and differences among COPD severity may be responsible for improvements in all parameters.

It was shown that skeletal muscle dysfunction is aproximately 30% in COPD (23). Several factors such as oxidative stress, nutritional disorders, body composition disorders, systemic inflammation and corticosteroid use have been implicated for the decrease in skeletal muscle function. In our study, there is an increase in exercise capacity after treatment, increased walking distance, which was found to decrease the sense of dyspnea during exercise. It has been shown that the reason for stopping the exercise testing is feeling fatigue in the legs more than dyspnea in COPD. Based on this information oxygenation of peripheral muscle and strengthening can be considered as an important factor influencing the exercise capacity. The reduction of physical activity in COPD may lead to social isolation, and depressive disorders. Higher depression levels were significantly decreased with PR in our patients. Exercise training causes psychological and physiological changes in healthy subjects as well as heart and lung diseases. Peripheral muscle oxidative capacity and thus increase in physical capacity occurs with exercise in COPD. There is reduction in ventilatory demand, blood lactate levels and respiratory distress. Thus patients perform more comfortable daily activities with less respiratory effort. Assessment of the patient's physical capacity is important for organization of appropriate education and detecting efficiency of the rehabilitation program.

It is recommended that information must be provided about regular and logical food intake, exercise habit, and cigarette-alcohol avoidance (24). We also questioned patients in terms of general measures such as exercise habits diet and smoking in our initial evaluation. We realized that most of the patients that we studied were unaware of general measures or they did not use in their daily practice. We detected that education of patients in terms of general measures has additional benefit to participation and continuing the program. In a study 6-MWT was used for measuring exercise capacity and decreased 6-MWT distance was associated with BMI, female gender, hypertension and lower FVC values (25). We also preferred 6-MWT for evaluating exercise capacity because it reflects functional capacity in daily activities, easy test with a higher patient compliance.

Various exercise programs provide an increase in exercise capacity in COPD (26). We detected an increase in 6-MWT after 8 weeks of respiratory muscles of the shoulder girdle and upper body-strengthening exercises with a resistance aerobic exercise training in our study. We consider that this result was effect of respiratory rehabilitation program on increased exercise and functional capacity.

There is increasing evidence that respiratory muscle dysfunction is present in chronic respiratory diseases. Studies concerning improving respiratory muscle dysfunction were conducted after knowledge about impact of respiratory muscle dysfunction on pathogenesis of COPD (27). We tried to improve respiratory muscle dysfunction with spesific exercises in our study.

We evaluated QoL with SF-36 which is known sensitive for following up treatment efficiency in COPD. Zoeckler et al has showed improvement of mental health and exercise capacity however there was lack of improvement in SF-36 results in their study which was consisted of 6-8 week PR program (28). In our study we showed significant improvements in all parameters of SF-36. This can be due to dietary modifications and our exercise program was conducted in hospital. We found that the level of anxiety was decreased in our patients after PR and this result might have been associated with a decrease in respiratory distress. There were improvements in respiratory parameters and exercise capacity as well as anxiety, depression and QoL scales in our study.

In a study by von Leupoldt et al; the intensive 3-week outpatient PR program was performed 6 h/d for 5 d/wk. Anxiety and depression were measured at the start and end of PR using the validated German version of the Hospital Anxiety and Depression Scale. QoL was assessed with SF-36. Most of the patients had stage II or III COPD. They have observed improved 6MWT, SF-36, anxiety and depression levels in this study (28). Also a meta-analysis about PR has showed significant improvement in QoL (7). The prevalence of depression was 40% and the prevalence of anxiety was 36% in patients with COPD (30). We detected higher levels of anxiety and depression parameters before rehabilitation program which were decreased after PR. Cycle ergometry assisted PR program is easily applicable, safe and comfortable method for the patient.

We consider that treatment programs on certain days of the week in the hospital improve the effectiveness of the implementation of the program. Advantages of the method are implementation of the resistance can be adjusted according to the patient, able to monitor oxygen saturation, heart rate and rhythm. A recent study concluded that PR may be also useful in home with increased QoL and exercise capacity (31).

Menadue C et al showed increased QoL and improved exercise tolerance using lower limb exercises and upper extremity strengthening exercises; however there was no significant change in pulmonary function tests in their 12-week home exercise program by cycle ergometer in patients with COPD (32). Nyberg A et al showed that 12 week home exercise program improved QoL and exercise tolerance in 43 patients with severe COPD (33). Normandin et al stated that low-density calisthenic type of exercise has impact on dyspnea, functional performance and QoL in patients with COPD (34). This study exercises were also took place in the hospital under supervision.

Main limitation of the study was we did not analyse body composition. The absence of the control group was another limitation.We could measure body composition in pre and post exercise program.

CONCLUSION

PR plays an important role in COPD with improved QoL, decreased respiratory distress, anxiety and depression. We suggest that PR should be accompanied to medical therapy in patients with COPD. This is the first study evaluating impact of PR with cycle ergometer in COPD. Further studies with more number of patients are necessary for determining optimal duration of PR program in COPD.

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